SUMITOMO FORESTRY

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For immediate release

Sumitomo Forestry Co., Ltd.

Sumitomo Forestry Co., Ltd. Conducts its own Shake Table Testing of a Full-scale 10-Story Mass-Timber Building in the U.S.

Testing under Japanese earthquake resistance standards, verification of high seismic resistance of post-tensioning seismic technology

Sumitomo Forestry Co., Ltd. (President and Representative Director: Toshirō Mitsuyoshi; Headquarters: Chiyoda-ku, Tokyo), is pleased to announce that it conducted shake table testing of a full-scale 10-story mass-timber building at the NHERI@UC San Diego Large High-Performance Outdoor Shake Table (LHPOST6) facility in California, USA. Sumitomo Forestry is participating in the NHERI TallWood Project*1 and in the second phase the test specimenwas retrofitted to our own original post-tension specifications and tested under Japanese earthquake resistance standards. The test building was confirmed to have a high degree of seismic resistance, withstanding multiple shake tests, including shaking equivalent to the tremors of the Great Hanshin-Awaji Earthquake. Sumitomo Forestry will continue to advance the implementation of this technology in medium- to large-scale wooden constructions both in Japan and around the world.

*1 NHERI TallWood Project
For details see press release of May 12, 2023: "World's First Shake Table Testing of a Full-scale 10-Story Mass-Timber Building Begins in the U.S."
https://sfc.jp/english/news/pdf/20230512_01.pdf
A project funded by National Science Foundation (NSF)*2 and United States Forest Service (USFS) and led by the Colorado School of Mines. The seismic performance and construction technology of medium and high-rise wooden buildings was examined by building a test specimen using post-tensioning seismic technology. In the first phase conducted by the U.S. researchers, shaking was implemented on a total of 88 occasions, using three levels of seismic waves based on the level of disasters on the West Coast area of the United States, and the building was confirmed to have suffered no damage.
*2 NSF (National Science Foundation)
A federal agency established in 1950 to promote science and technology in the United States. The NSF has produced many innovative research results, including more than 160 Nobel Prize winning discoveries.

■ Outline of Experient (Phase 2)

In the first phase the seismic resistance of the test building was confirmed using three levels of seismic waves based on the level of disasters on the West Coast area of the United States. In the second phase Sumitomo Forestry conducted our own experiments from July 28 to August 10. The NHERI TallWood Project test building was retrofitted to our original post-tension specifications, capable of withstanding the seismic force of Japanese earthquake resistance standards. The second phase was planned in cooperation with U.S. researchers and the Isoda Laboratory, Research Institute for Sustainable Humanosphere, Kyoto University. We verified seismic performance by testing resistance to seismic waves the same as those actually experienced in Japan, and seismic waves that require resistance confirmation under the Building Standards Act. We also confirmed the resilience of post-tensioning seismic technology.*3

Test building on the University of California, San Diego (UCSD) Outdoor Shake Table

*3 Post-tensioning seismic technology

A technology that increases the fixation between the structural components by applying tensile stress to high-strength steel rods or wire ropes that are threaded through the load bearing members.

1) Verification contents and conditions

- Waves equivalent to seismic motions stipulated by the Building Standards Act of Japan when designing high-rise buildings (simulated and observed waves [level equivalent to rare and extremely rare earthquake])
- Long-period seismic motions due to a massive earthquake along the Nankai Trough*4
- Great Hanshin-Awaji Earthquake (Southern Hyogo Prefecture Earthquake): JMA Kobe wave (Seismic wave measured by Kobe Marine Observatory in 1995)
- Maximum anticipated earthquake under U.S. standards, as used in Phase 1: MCE level-adjusted wave (major earthquake with a recurrence period of 2,475 years in Seattle)

The test building was shaken a total of 51 times using seismic waves equivalent to the abovementioned major earthquakes.

*4 Long-period seismic motions due to a massive earthquake along the Nankai Trough
Long-period seismic motions for design purposes, prepared pursuant to the Technical Advice of the Ministry of Land, Infrastructure, Transport and Tourism (June 24, 2016, MLIT Housing Bureau Directive No. 1111), which was compiled as a countermeasure against long-period seismic motions in super high-rise buildings, etc.: Kanto Area 1 (KA1).

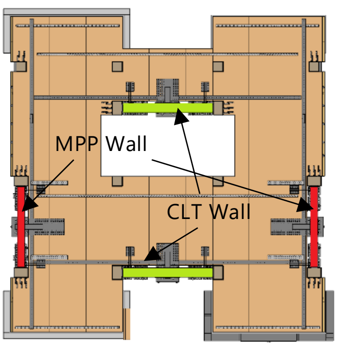
2) Verification results

- The building withstood multiple shake tests and retained its stability, including shaking equivalent to the seismic motion experienced during the Great Hanshin-Awaji Earthquake.
- At the end of each test shake the test building returned to an upright position using its own restorative force (maximum inter-story drift angle*5 reached 1/40 rad).
- After all 51 earthquake loading, the test specimen had suffered no damage, including the timber used in the building structure.
- Much of the energy from the shaking was absorbed by the dampers.

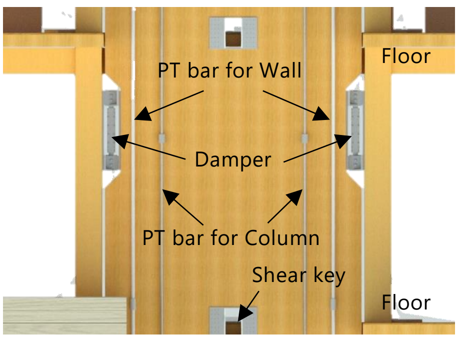
*5 Inter-story drift angle
Angle θ (θ=δ/h) obtained from the horizontal deformation (δ) and height (h) occurring on each floor due to the impact of an earthquake or strong winds, using the unit rad (radian). The Building Standard Act stipulates that, in the event of seismic forces that occur extremely rarely (once every several hundred years), buildings must not be damaged in such a way that would result in the loss of human life. Conventionally, the limit of the inter-story drift angle in such situations (safety limit inter-story drift angle) is usually set at 1/75 rad, but if it were to exceed this stipulated limit, it must be confirmed that the building would not collapse even when the overturning force amplified by the tilt is taken into account. In this test the inter-story drift angle exceeded 1/75 rad, reaching a maximum 1/40 rad, but at the end of each test shake, the structural frame of the test building returned to an upright position using its own restorative force, thus verifying the high resilience of the post-tensioning seismic technology.

3) Retrofitting details

Structural form: Mass-timber construction (post-and-beam) using post-tensioning seismic technology
No. of floors: 10
Area: 10.5m×10.6m
Height: 34.14m
Floor height: [1F] 3.96m, [Other floors] 3.35m
Materials: [Column beam] LVL*6, [Load-bearing wall] CLT*7, MPP*8



Plan layout



Wall detail

Test building Phase 2 specifications

The load-bearing walls comprise supporting columns and walls (CLT or MPP). Each floor is structured as detailed in the diagram on the right. The test building was retrofitted to include Sumitomo Forestry's original damper, change the configuration of the post-tension (PT) steel rods, and increase the wall post-tensioning force, among other modifications.

*6 LVL (Laminated Veneer Lumber)
A wood material made by laminating and bonding veneers made of peeled logs in parallel directions of fibers.

*7 CLT (Cross Laminated Timber)
After arranging the laminar, the wood material is laminated and bonded so that the fibers are in an orthogonal direction.

*8 MPP (Mass Plywood Panel)
A large-section wood material made by laminating plywood by secondary adhesion. A wood-based material developed in the United States that is not standardized in Japan yet.

■ Future Vision

Sumitomo Forestry has been researching post-tensioning seismic technology as one of the technologies for constructing medium- to large-scale wooden buildings since 2014. This technology was adopted for the first time in 2015, for the Fire labo building of our Tsukuba Research Institute, and again in 2019 the new research building of the institute. The first commercial example of such construction was Building No. 15 of Sophia University's Yotsuya Campus, which was completed in June 2022.

In the United States, design methods for post-tensioning seismic technology are scheduled to be added to the International Building Code (IBC; U.S. Building Code) by 2028. Based on the knowledge gained from this project, this technology will be deployed in Japan and around the world as a solution for medium- and large-scale wooden constructions.

The Sumitomo Forestry Group is globally engaged in wood-centered businesses, including forest management, the manufacture and distribution of timber building materials, detached houses, medium- to large-scale wooden construction contracting, real estate development, and wood biomass power generation. Under our long-term vision to 2030 "Mission TREEING 2030" we aim to increase the amount of CO_2 absorbed by forests by running the "Wood Cycle" value chain of Sumitomo Forestry, and contribute to decarbonization not only for our company but also for society as a whole by fixing carbon over the long term through the popularization of wooden buildings. Sumitomo Forestry is committed to continuing research and development that maximizes the value of woods and trees.